ESRF	**Experiment title:** Magnon folding in a charge ordered cuprate superconductor	**Experiment number**: HC-3888
Beamline:	**Date of experiment**: from: Oct. 17, 2018 to: Oct. 23, 2018	**Date of report**: Feb. 05, 2020
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Report:

A) Overview

We proposed to we propose to study how charge stripe order – found in a narrow doping range around 1/8 doping – folds the spin-excitation dispersion. From preliminary RIXS data we have discovered hints consistent with a 100 meV folding gap in the paramagnon dispersion of $La_{2-x}Sr_xCuO4$ (LSCO) with $x = 0.12$. With the energy resolution of 60 meV (FWHM) of the ERIXS spectrometer, this folding gap can be directly resolved. Proving the existence of such a gap would demonstrate whether high-energy spin excitations directly couple to the doping dependent ground state of underdoped cuprate.

B) Experimental results

In the original proposal, we planed to measure LSCO at 1/8 doping. It is known that the charge stripe order can be largely enhanced by replacing Sr with Ba [1]. In order to better resolve the subtle band folding effect, we have therefore performed measurements on the sister compound $La_{2-x}Ba_xCuO_4$ (LBCO) with $x = 1/8$. To enhance the single magnon excitations, the RIXS spectra were collected with LH light polarisation in grazing exit geometry.

Fig. 1(a) shows the low energy part of RIXS spectra taken at 20 K along the longitudinal direction through the charge ordering wavevector $\mathbf{Q}_{CO}$= (0.235,0). In this waterfall plot, we clearly see that the magnon peak is broadened at $\mathbf{Q}_{CO}$ with a shoulder-like feature appearing on the high-energy side (indicated by the red arrow). The fitted magnon excitation energy and the peak width (full width at 85% maximum) are shown in Fig. 1(b). While a prominent anormaly of magnon peak width is found at $\mathbf{Q}_{CO}$, the fitted energy dispersion also displys a

kink at this momentum. These high quality results are consistent with the picture of mangon band folding due to charge stripes and more detailed analysis are undergoing.

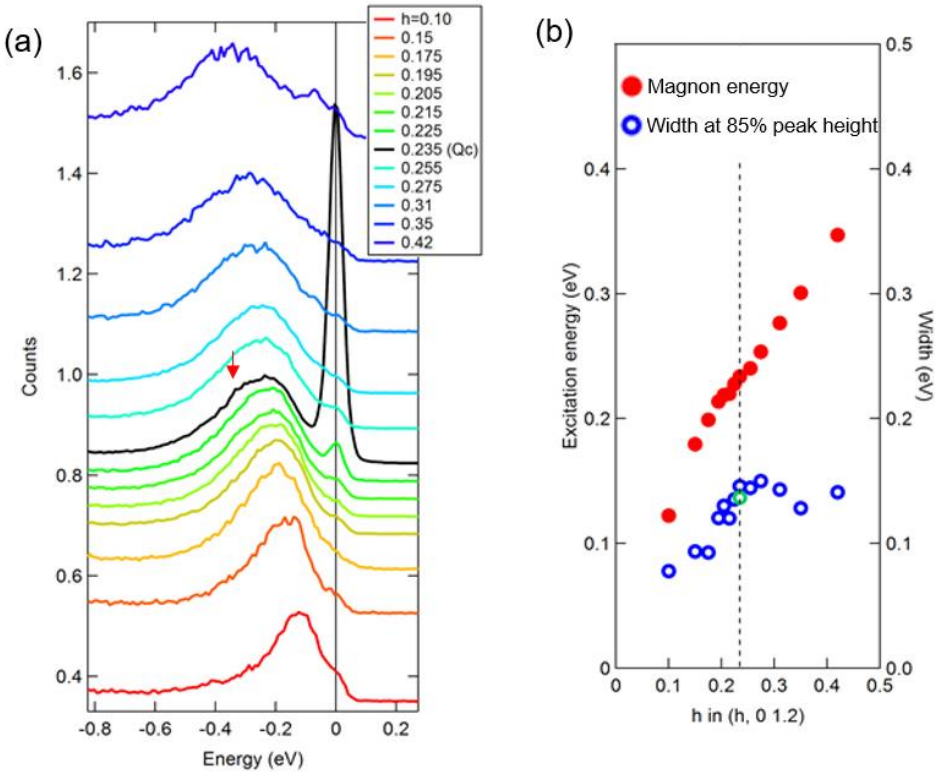

Fig. 1(a) RIXS spectra taken through $\mathbf{Q}_{CO}$ on LBCO at 20 K. (b) Magnon energy and width extracted from fittings of the low-energy RIXS spectra.

C) Publication

Part of the data collected from this experiment have been included in a manuscript that has been submitted to Physical Review Letters. A preprint is now available [Q. Wang *et al.*, arXiv:1912.0019]. The abstract of this manuscript is shown below.

We use resonant inelastic x-ray scattering (RIXS) to investigate charge-stripe correlations in $La_{1.675}Eu_{0.2}Sr_{0.125}CuO_4$ (LESCO-1/8). By dierentiating elastic from inelastic scattering, it is demonstrated that charge-stripe correlations precede both the structural low-temperature tetragonal (LTT) phase and the transport-dened pseudogap onset. The scattering amplitude from charge-stripes seems to have no characteristic onset temperature T. Instead, it scales as T^{-2} while the integrated in-plane intensity is roughly temperature independent. Although the incommensurability shows a remarkably large increase at high temperature, our results are interpreted via a single scattering constituent. In fact, direct comparison to other stripe-ordered compounds ($La_{1.875}Ba_{0.125}CuO_4$, $La_{1.475}Nd_{0.4}Sr_{0.125}CuO_4$ and $La_{1.875}Sr_{0.125}CuO_4$) suggests a roughly constant integrated scattering intensity across all these compounds. Our results therefore provide a unifying picture for the charge-stripe ordering in La-based cuprates. As charge correlations in LESCO-1/8 extend beyond the LTT and pseudogap phase, their emergence heralds a spontaneous symmetry breaking in this compound [2].

References

[1] J. M. Tranquada, AIP Conf. Proc. **1550,** 114 (2013)

[2] Q. Wang *et al.*, arXiv:1912.0019